



**ILLINOIS NATURAL
HISTORY SURVEY**
PRAIRIE RESEARCH INSTITUTE

Northern Riffleshell and Clubshell 2015 Monitoring Results

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Executive Summary

In 2015, staff from the Illinois Natural History Survey continued to monitor translocated populations of two federally-endangered freshwater mussel species in the Vermilion River basin (Wabash River drainage). Between 2010 and 2014, a total of 2,099 Northern Riffleshell (*Epioblasma rangiana*) and 1,766 Clubshell (*Pleurobema clava*) have been translocated to eight sites in the Vermilion River basin, Champaign and Vermilion counties, Illinois. These translocated animals have been monitored seasonally since being moved to Illinois. For the 2015 calendar year, 36% (716) of the 1,991 available Northern Riffleshell were encountered, and of those physically examined, 61% (54 of 88) were alive. Conversely, 77% (1,359) of the 1,758 available Clubshell were encountered, and of those examined, 82% (106 of 129) were alive. The encounter and survival rates from the raw data collected in 2015 were comparable to previous years in Illinois. Throughout the duration of the project, both Northern Riffleshell and Clubshell have had higher encounter rates in the spring and autumn than summer. This relocation project is being funded, in part, by a natural resource damage assessment settlement (Hegeler Zinc—Lyondell Basell Companies) to the U.S. Fish and Wildlife Service and to the State of Illinois, and by the U.S. Fish and Wildlife Service’s Ohio River Basin Fish Habitat Partnership.

Project History

[from Tiemann (2014, 2015)]

The Northern Riffleshell *Epioblasma rangiana* and Clubshell *Pleurobema clava* were once widespread throughout the Ohio River basin but both have experienced significant range reductions during the last century as a result of reduced habitat and water quality. Because of this range reduction, the U.S. Fish and Wildlife Service listed both species as federally-endangered in 1994. The joint recovery plan listed an objective of establishing viable populations of the species in ten separate river drainages throughout their respective ranges, and stated that population augmentations and reintroductions would be needed to achieve this objective. Beginning in 2005, natural resource agencies in Illinois partnered with the USFWS and natural resource agencies in Ohio, Pennsylvania, and West Virginia, and began implementing portions of the recovery plan. One goal of the recovery team was to re-establish self-sustaining Northern Riffleshell and Clubshell populations in the Vermilion River basin (Wabash River drainage) in Illinois.

A salvage project in Pennsylvania in the Allegheny River provided an opportunity for the translocation of both species. Between 2010 and 2014, 2,099 Northern Riffleshell (1,196 males and 903 females) and 1,766 Clubshell were PIT (passive integrated transponder) tagged and translocated from the Allegheny River beneath the U.S. Highway 62 (=Hunter Station) Bridge, Tionesta Township, Forest County, Pennsylvania, to eight sites in the Vermilion River basin in Champaign and Vermilion counties, Illinois (Figure 1). Of those eight sites, six¹ (three in the Salt Fork and three in the Middle Fork) were selected for continued translocation and monitoring based upon high encounter and survivorship rates.

Prior to the 2015 efforts, 3,450 (89%) of the 3,865 translocated individuals were encountered once – 1,735 (83%) of the 2,099 placed Northern Riffleshell and 1,715 (97%) of the 1,766 placed Clubshell (Tiemann 2015). Encounter rates were highly variable by site, season, and species (tables 1 and 3). Since the inception of the monitoring program through 2014, the seasonal encounter rate per site varied from 3% to 100% with a project mean of 42% for the Northern Riffleshell and from 37% to 100% for the Clubshell with a project mean of 70% (tables 1 and 3). Of the individuals examined prior to 2015, 58% of the Northern Riffleshell and 83% of the Clubshell were alive.

2015 Project Activities

No additional mussels were translocated from Pennsylvania to Illinois during the 2015 calendar year. However, the six established populations were monitored during three sampling events (spring, summer, and autumn). When monitoring PIT-tagged mussels, at least two samplers used a PIT tag reader to slowly sweep over the streambed in a systematic manner (Tiemann 2014). Detected tag data were stored in the PIT reader and later downloaded into a database after the sampling period ended. At least one additional sampler snorkeled (or used view buckets) if conditions were favorable and visually examined the streambed for tagged mussels. If a tagged mussel was seen, a note was made in the database whether that individual was alive or dead. The region sampled included the area stocked plus a 20-meter buffer to

¹ The six selected sites are Smith, Richter, and Donut in the Salt Fork, and Ford, Horse, and Kennekuk, in the Middle Fork. Locations are referenced in Figure 1.

account for mussels moving or washing downstream. Conditions (e.g., water levels and ice) were not always favorable to allow monitoring at all sites during a season (tables 1-4).

For the 2015 calendar year, 36% (716) of the 1,991 available Northern Riffleshell were encountered. The seasonal encounter rate per survey per site varied from 3% to 67% (Table 1). Conversely, 77% (1,359) of the 1,758 available Clubshell were encountered. The seasonal encounter rate per survey per site varied from 11% to 89% for the Clubshell (Table 3). Throughout the project, seasonal encounter rates have been highest in spring and autumn for both Northern Riffleshell and Clubshell (Figure 2). This pattern held true for both Northern Riffleshell males and females (Figure 3). Northern Riffleshells are bradytictic (winter breeders) and move to the substrate surface during winter and spring (Watters et al., 2009). This vertical migration might account for the lower seasonal encounter rates during the summer. However, this theory seems invalid for Clubshells, which are tachytictic (summer breeders) and tend to come to the substrate surface during warmer months (Watters et al., 2009). It cannot be ruled out that the high seasonal encounter rates in autumn are resultant of the timing of translocations. During all four translocation events (2010, 2012, 2013, and 2014), mussels were moved to Illinois in late August or early September when water temperatures were the most comparable among the Allegheny River, the well water at the INHS pond site (=quarantine facility), and the Vermilion River basin. The autumn monitoring events usually occurred late October to mid-November, which is approximately two months post-translocation and might not be enough time for animals to bury or disperse upstream or downstream.

There is a steady decline in annual encounter rates² post translocation. Clubshell have experienced an approximate 20% drop in annual encounter rates per year since initial stocking, whereas Northern Riffleshell have experienced a more significant decline (Figure 4). These declines have fluctuated widely by species and by site (Table 5), which suggests which species-site combination might be successful and worthy of future translocations. Thus far, Clubshell at Donut and Smith have had the highest annual encounter rates on the Salt Fork and Clubshell at Ford has had the highest annual encounter rate on the Middle Fork, suggesting that the majority of the Clubshell are staying within the respective project areas and not being carried downstream or burying beyond the detectability range of the PIT tag reader. Although the

² Annual encounter rates track individuals throughout time on a yearly basis. An individual usually has three chances of begin encountered during a given year – during autumn, spring, or summer.

drastic decline in Northern Riffleshell annual encounter rates at all sites is somewhat alarming, the species is known to vertically migrate. It is possible that the majority of individuals are outside the detection range during spring, summer, and autumn and could migrate to the surface during winter. Repeated monitoring during winter should help alleviate some of the ambiguity.

Of individuals examined in the 2015 calendar year, 61% (54 of 88) of the Northern Riffleshell were alive³ and 82% (106 of 129) of the Clubshell were alive, which are comparable to previous years in Illinois. Of the individuals examined since the inception of the project, 60% of the Northern Riffleshell³ and 83% of the Clubshell have been alive (tables 2 and 4). It is important to note, a manure spill in the Stony Creek basin, a tributary to the Salt Fork, occurred on 11 September 2015 near the village of Muncie. Over 100,000 gallons of liquid manure were accidentally discharged into Conkey Branch (=Stony Creek), resulting in nearly 100,000 dead fishes over a course of 10 stream miles, including portions of the Salt Fork that included the Richter relocation site (Trent Thomas, Illinois Department of Natural Resources, personal communication). INHS and USFWS staff visited the relocation site on 17 September 2015 and detected 26 tagged animals. These animals were excavated and included one fresh-dead (=in situ without flesh but hinge line still pliable) Northern Riffleshell, 21 live Clubshell, three fresh-dead Clubshell, and one additional dead Clubshell that appears to have been dead prior to the spill based upon algae on shell. Six other freshwater mussel species, including the state-endangered Wavyrayed Lampmussel (*Lampsilis fasciola*) and state-threatened Purple Wartyback (*Cyclonaias tuberculata*), were encountered alive at the relocation site after the manure spill. With the approval of both USFWS and IDNR, we were able to excavate a larger portion of detected individuals at Smith and Donut in Autumn 2015 to compare survival of known fate individuals among sites in the Salt Fork post manure spill. Of the 20 individuals excavated at Smith, 17 were live Clubshell, one was a live Northern Riffleshell, and one Clubshell and one Northern Riffleshell were found dead in an exposed gravel bar. Of the 11 individuals excavated at Donut, six were live Clubshell, and five were live Northern Riffleshell. It was difficult to what, if any, the spill had on the relocated mussel population. A separate survey in Stony Creek after the spill occurred revealed a live Rainbow (*Villosa iris*), a state-endangered species, thus it appears that mussels were able to survive the spill.

³ For 2015, 67% (36 of 54) male Northern Riffleshells and 53% (18 of 34) female Northern Riffleshells examined were alive. For the duration of the project, 66% of the males and 51% of the females examined have been alive.

Frequent high-water events causing mussels to dislodge and wash downstream or be transported downstream and buried with the sediment load appears to be the most detrimental factor to survival of the relocated animals. In the Middle Fork, 5 rain events have caused the river to rise above 5000-cfs since translocations began in 2013; four of those events occurred in a six month period in 2015 – early March, mid-May, early June and mid-September (Figure 5). Similarly, since translocations began in the Salt Fork in 2010, four of the highest eight discharge events occurred in during the same six-month period in 2015. More than 60 individuals placed at a given site have been found dead outside of the project area. For example, one individual from the 2012 translocation cohort at Richter was found alive in Spring 2015 in the location where it was originally placed, but was detected in Autumn 2015 at a gravel bar ~0.75 km downstream (Figure 6); although detected in Autumn 2015, the individual was buried in the substrate and was not found recovered. It is important to note that not all individuals washed downstream perished. Eleven of the 61 animals detected outside of the project area were excavated and found alive, 44 were excavated and found dead, and six were unable to be located during excavation so their status is unknown. Frequent high water events that move mussels downstream could interfere with the animals' reproductive cycle and jeopardize the success of the project. Both Northern Riffleshell and Clubshell migrate to the streambed surface during certain times of the year. If reproductively viable individuals became displaced, they might not be able to release gametes or glochidia, or in the case of Northern Riffleshell, might be carried into a pool that has low darter (=host fish) density or unsuitable habitat.

Efforts are underway to use a statistical modeling approach to estimate survival and detection, as well as the most important factors that influence these metrics. The model estimates should be able to provide species-, site- and stream-specific survival and detection estimates that will be informed by data across all sites. We also will be able to estimate the effect size of particular factors on detection and survival, such as water temperature and flow rates.

Future Plans

As discussed in Tiemann (2014, 2015), this project will assess performance of translocations, and is expected to provide benefits identified in the USFWS' recovery plan of the Clubshell and Northern Riffleshell (USFWS 1994), including establishing viable populations, maintaining genetic variability and potentially reclassifying the species from endangered to

threatened. Future plans include seasonally monitoring of sites for several years. Animals will be documented via PIT tag readers and a small percentage will be excavated to assess survival. USFWS, IDNR, and INHS staff will meet at least yearly to determine how many additional mussels should be translocated to Illinois and where those animals will go. Once those discussions are agreed upon, the staff will work with governing agencies in Pennsylvania to translocate additional Northern Riffleshell and Clubshell to Illinois to augment the selected established sites or to potentially establish new sites. As time and budgets allow, data will be presented at meetings and conferences, and data will be shared with collaborative partners in Pennsylvania, Indiana, Ohio, West Virginia, Kentucky, and New York.

Acknowledgements

This project is a collaborative effort among the U.S. Fish and Wildlife Service, Pennsylvania Fish and Boat Commission (PFBC), Pennsylvania Department of Transportation (Penn DOT), Illinois Department of Natural Resources ([IDNR], including the Illinois Nature Preserves Commission and the Illinois Endangered Species Protection Board), Illinois Natural History Survey (INHS), University of Illinois (U of I), Champaign County Forest Preserve District (CCFPD), Vermilion County Forest Preserve District, the Ohio State University (OSU), Columbus Zoo and Aquarium, West Virginia Department of Natural Resources (WV DNR), Kentucky Department of Fish and Wildlife, and BioMark, Inc. Throughout the project, the following people have provided valuable assistance: Jordan Allison (PFBC), Robert Anderson (USFWS), Sarah Baker (INHS), Drew Becker (USFWS), Tara Beveroth (INHS), Angela Boyer (USFWS), Steve Buck (U of I), Janet Clayton (WV DNR), Evan Cropek (INHS), Kevin Cummings (INHS), Tyson Dallas (IDNR), Patty Dickerson (INHS), Sarah Douglass (INHS), Michael Dreslik (INHS), Jon Duyvejonck (USFWS), Terry Esker (IDNR), Sheldon Fairfield (IDNR), Nathan Grider (INHS), Kelly Hannan (U of I), Tom Heavisides (IDNR), Bridget Henning (IDNR), John Hott (IDNR), Joseph Kath (INDR), Andrew Kuhns (INHS), Rich Lewis (IDNR), Kristen Lundh (USFWS), Anne Mankowski (IDNR), Christine Mayer (INHS), Kraig McPeck (USFWS), Jean Mengelkoch (INHS), Eleanor Moen (INHS), Patty Morrison (USFWS), Jen Mui (INHS), Kelly Neal (IDNR), Dan Olson (CCFPD), Jessica Riney (IDNR), Jason Robinson (INHS), Robert Schanzle (former IDNR), Josh Sherwood (INHS), Jody Shimp (IDNR), the Smith Family, Joseph Snavelly (URS Corporation), Mary Kay Solecki (IDNR), Jeff

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Appendix 1 – Tables and Figures

Table 1. Encounter rates for Northern Riffleshell by site (with stream name) per sampling period. Data are “number detected / maximum number of individuals in the stream at a site at that period.” Site information can be found in Tiemann (2014). “NS” = not sampled and "-" = sites were not yet established. *Only half of the Richter site was sampled.

	<i>Richter</i> (Salt)	<i>Smith</i> (Salt)	<i>Donut</i> (Salt)	<i>MFNP</i> (Middle)	<i>Ford</i> (Middle)	<i>Horse</i> (Middle)	<i>Kennekuk</i> (Middle)	<i>Beaver</i> (Middle)	<i>Total</i> %
Summer 2011	39/69	-	-	31/67	-	-	-	-	51%
Autumn 2011	12/66	-	-	28/67	-	-	-	-	30%
Spring 2012	38/66	-	-	NS	-	-	-	-	58%
Summer 2012	35/66	-	-	30/63	-	-	-	-	50%
Autumn 2012	321/555	302/472	-	NS	-	-	-	-	61%
Summer 2013	98/555	222/465	-	13/61	-	-	-	-	31%
Autumn 2013	37/550	235/464	50/50	NS	48/50	50/50	45/49	44/50	40%
Winter 2014	NS	NS	17/50	NS	35/50	NS	11/49	NS	43%
Spring 2014	NS	NS	NS	NS	29/50	19/50	11/49	9/50	34%
Summer 2014	20/546	116/446	20/50	NS	25/50	19/50	9/49	11/50	18%
Autumn 2014*	6/196	NS	275/336	NS	171/227	149/217	96/169	8/50	59%
Spring 2015	NS	NS	193/336	NS	151/227	80/217	89/169	NS	54%
Summer 2015	16/546	96/446	188/336	NS	20/227	25/217	10/169	NS	18%
Autumn 2015	34/546	99/446	181/335	NS	19/227	9/217	11/169	5/50	18%

Table 2. Survival of known fate individuals for Northern Riffleshell by site (with stream name) per sampling period. Data are “number alive / (number alive + number dead).” Site information can be found in Tiemann (2014). “NS” = not sampled, and "-" = sites were not yet established. *All individuals encountered during this time period were at surface and were left in stream, regardless of live or dead.

	<i>Richter</i> (Salt)	<i>Smith</i> (Salt)	<i>Donut</i> (Salt)	<i>MFNP</i> (Middle)	<i>Ford</i> (Middle)	<i>Horse</i> (Middle)	<i>Kennekuk</i> (Middle)	<i>Beaver</i> (Middle)	<i>Total</i>
Summer 2011	5/8	-	-	9/9	-	-	-	-	14/17
Autumn 2011	6/6	-	-	15/19	-	-	-	-	21/25
Spring 2012	2/2	-	-	NS	-	-	-	-	2/2
Summer 2012	0/0	-	-	4/6	-	-	-	-	4/6
Autumn 2012	3/3	0/7	-	NS	-	-	-	-	3/10
Summer 2013	17/22	8/9	-	6/7	-	-	-	-	31/38
Autumn 2013*	0/3	3/21	1/1	NS	0/7	2/2	0/3	1/11	7/48
Winter 2014	NS	NS	0/0	NS	0/0	NS	0/0	NS	0/0
Spring 2014	NS	NS	NS	NS	0/0	0/0	0/0	0/0	0/0
Summer 2014*	0/1	0/0	1/1	NS	0/0	0/0	3/3	1/3	5/8
Autumn 2014*	0/0	NS	0/0	NS	7/7	0/0	3/3	0/0	10/10
Spring 2015*	NS	NS	4/5	NS	20/22	3/3	11/11	NS	38/41
Summer 2015	2/4	1/1	0/2	NS	3/3	0/0	1/1	NS	7/11
Autumn 2015	3/22	1/2	5/5	NS	0/0	0/4	0/3	0/0	9/36
Total	38/71	13/40	11/14	34/41	30/39	5/9	18/24	2/14	151/252

Table 3. Encounter rates for Clubshell by site (with stream name) per sampling period. Data are “number detected / maximum number of individuals in the stream at a site at that period.” Site information can be found in Tiemann (2014). “NS” = not sampled and "-" = sites were not yet established (e.g., no Clubshell placed at MFNP). *Only half of the Richter site was sampled.

	<i>Richter</i> (Salt)	<i>Smith</i> (Salt)	<i>Donut</i> (Salt)	<i>MFNP</i> (Middle)	<i>Ford</i> (Middle)	<i>Horse</i> (Middle)	<i>Kennekuk</i> (Middle)	<i>Beaver</i> (Middle)	<i>Total</i> %
Summer 2011	-	-	-	-	-	-	-	-	-
Autumn 2011	-	-	-	-	-	-	-	-	-
Spring 2012	-	-	-	-	-	-	-	-	-
Summer 2012	-	-	-	-	-	-	-	-	-
Autumn 2012	73/110	51/91	-	-	-	-	-	-	62%
Summer 2013	41/110	64/91	-	-	-	-	-	-	52%
Autumn 2013	301/368	271/340	50/50	-	46/50	50/50	48/50	49/50	85%
Winter 2014	NS	NS	41/50	-	44/50	NS	20/50	NS	70%
Spring 2014	NS	NS	NS	-	47/50	32/50	27/50	43/50	75%
Summer 2014	190/367	286/338	42/50	-	47/50	31/50	20/50	41/50	69%
Autumn 2014*	202/363	NS	296/328	-	194/225	197/231	173/224	41/50	78%
Spring 2015	NS	NS	263/327	-	173/225	187/231	165/224	NS	78%
Summer 2015	116/363	288/338	240/327	-	107/225	96/231	21/224	NS	51%
Autumn 2015	154/363	300/338	240/327	-	102/225	25/231	24/224	38/50	50%

Table 4. Survival of known fate individuals for Clubshell by site (with stream name) per sampling period. Data are “number alive / (number alive + number dead).” Site information can be found in Tiemann (2014). “NS” = not sampled and "-" = sites were not yet established (e.g., no Clubshell placed at MFNP). *All individuals encountered during this time period were at surface and were left in stream, regardless of live or dead.

	<i>Richter</i> (Salt)	<i>Smith</i> (Salt)	<i>Donut</i> (Salt)	<i>MFNP</i> (Middle)	<i>Ford</i> (Middle)	<i>Horse</i> (Middle)	<i>Kennekuk</i> (Middle)	<i>Beaver</i> (Middle)	<i>Total</i>
Summer 2011	-	-	-	-	-	-	-	-	-
Autumn 2011	-	-	-	-	-	-	-	-	-
Spring 2012	-	-	-	-	-	-	-	-	-
Summer 2012	-	-	-	-	-	-	-	-	-
Autumn 2012	0/0	0/0	-	-	-	-	-	-	0/0
Summer 2013	5/5	2/2	-	-	-	-	-	-	7/7
Autumn 2013	0/0	0/2	0/0	-	0/0	0/0	0/0	0/0	0/2
Winter 2014	NS	NS	0/0	-	0/0	NS	0/0	NS	0/0
Spring 2014	NS	NS	NS	-	0/0	0/0	0/0	0/0	0/0
Summer 2014*	1/2	2/2	4/4	-	13/13	3/3	3/3	4/7	30/34
Autumn 2014*	0/0	NS	0/0	-	0/0	0/0	1/1	0/0	1/1
Spring 2015*	0/0	0/0	3/3	-	9/9	1/1	16/16	NS	29/29
Summer 2015	25/29	6/6	4/5	-	10/10	0/0	0/0	NS	45/50
Autumn 2015	7/20	17/18	6/6	-	0/0	0/1	2/5	0/0	32/50
Total	38/56	27/30	17/18	-	32/32	4/5	22/25	4/7	144/173

Table 5. Annual encounter rates by year post translocation per cohort per site for Northern Riffleshell (NRS) and Clubshell (CS). Site information can be found in Tiemann (2014). The first Clubshell translocation to Illinois occurred in 2012, and no Northern Riffleshell were translocated to either Richter or Smith in 2013. Richter 2010 cohort was not detected during Year 4 and only 9 of 69 individuals were detected in Year 5.

Salt Fork relocation sites

	Richter 2010			Richter 2012			Richter 2013		Smith 2012			Smith 2013		Donut 2013		Donut 2014
	Yr 1	Yr 2	Yr 3	Yr 1	Yr 2	Yr 3	Yr 1	Yr 2	Yr 1	Yr 2	Yr 3	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1
NRS	57%	61%	17%	78%	11%	3%	-	-	81%	54%	22%	-	-	100%	52%	94%
CS	-	-	-	80%	50%	33%	98%	67%	85%	88%	68%	97%	92%	100%	98%	99%

Middle Fork relocation sites (“Kenn” = Kennekuk)

	Ford 2013		Ford 2014	Horse 2013		Horse 2014	Kenn 2013		Kenn 2014
	Yr 1	Yr 2	Yr 1	Yr 1	Yr 2	Yr 1	Yr 1	Yr 2	Yr 1
NRS	98%	40%	90%	100%	44%	71%	98%	22%	78%
CS	100%	92%	95%	100%	72%	98%	100%	40%	92%

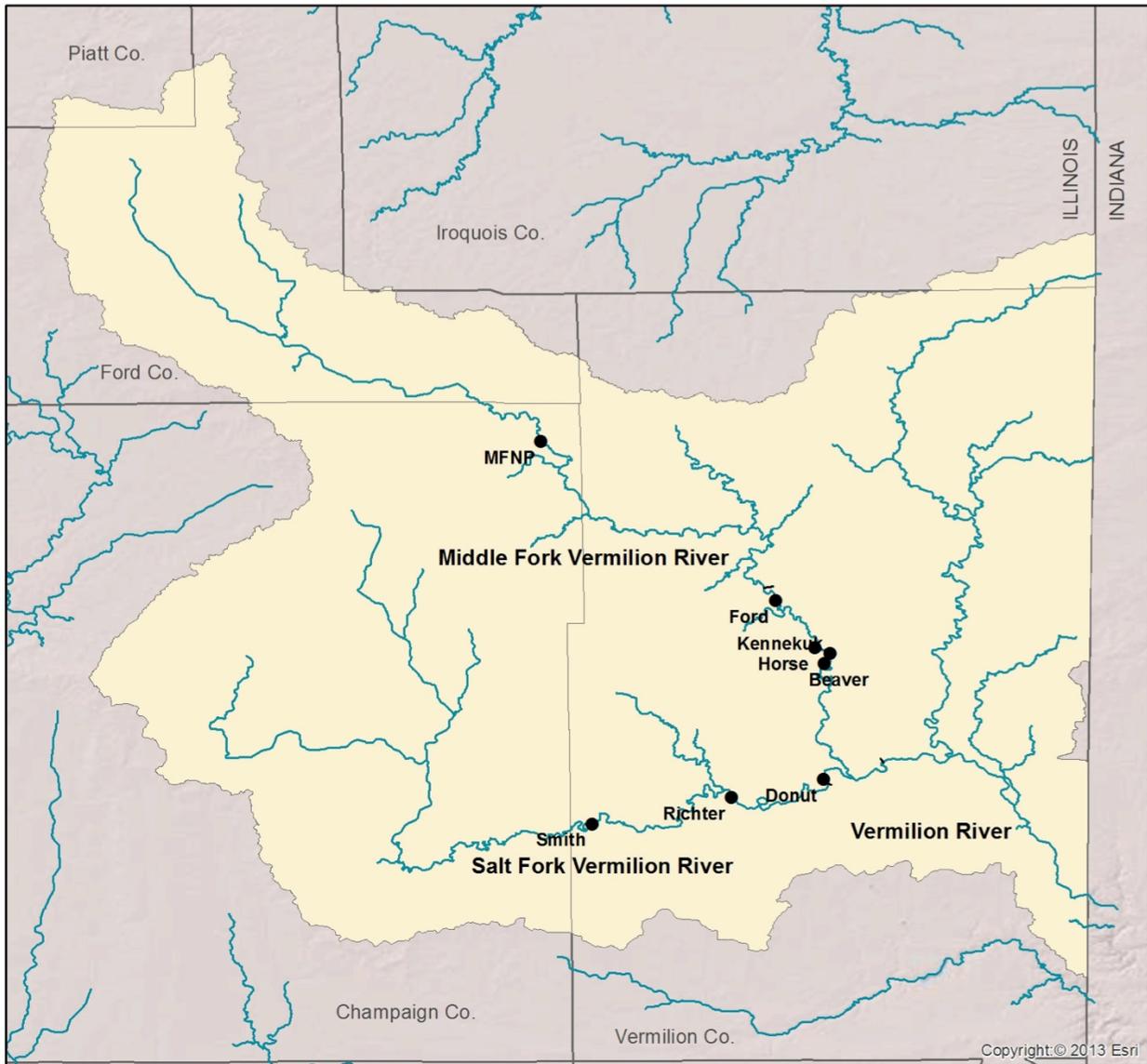


Figure 1. Translocation sites from for Northern Riffleshell and Clubshell in the Vermilion River basin (Wabash River drainage).

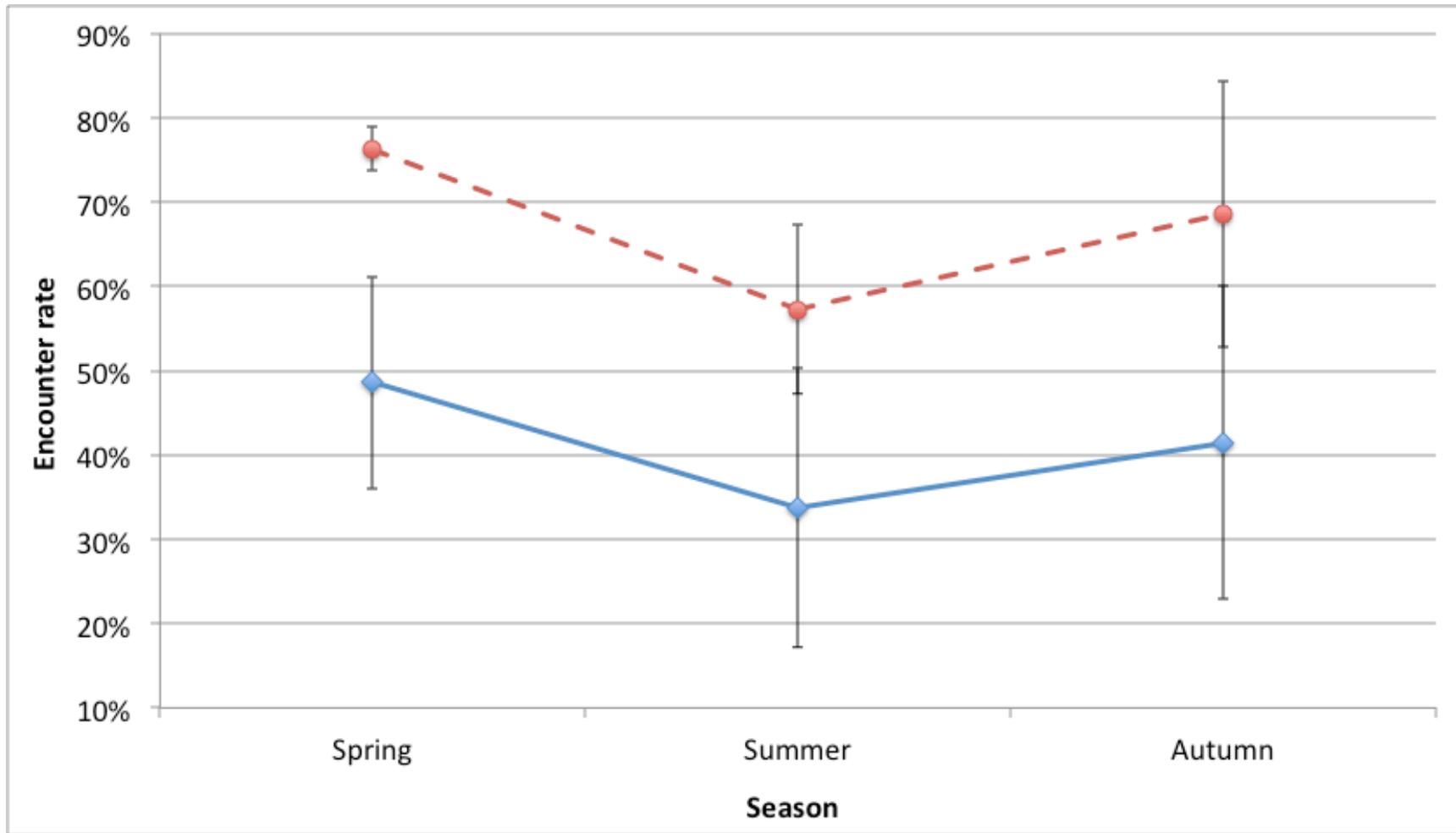


Figure 2. Mean seasonal encounter rates (\pm standard sample deviation) by season from Summer 2011 to Autumn 2015 for Northern Riffleshell (solid blue line) and Clubshell (dashed red line) with standard deviation bars.

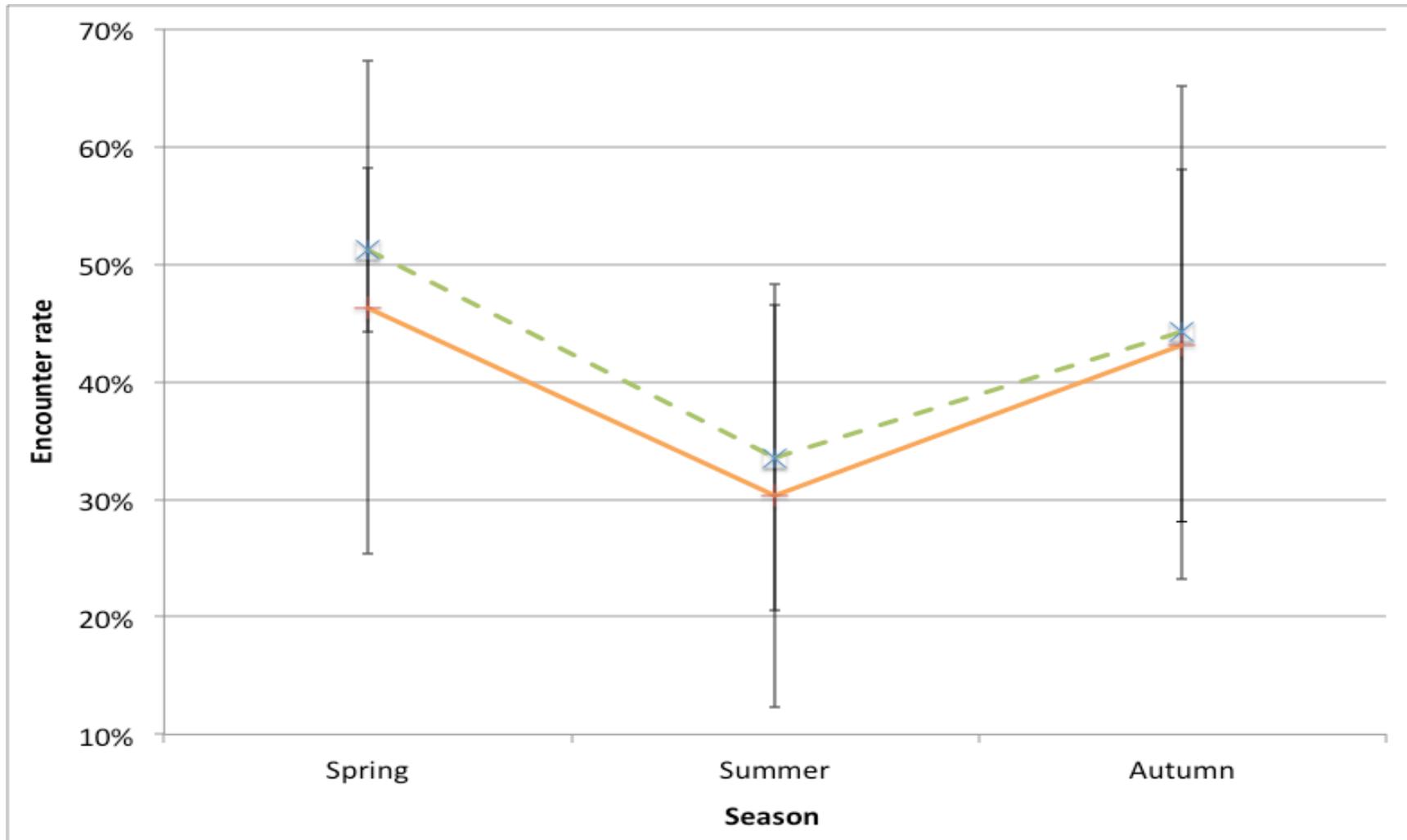


Figure 3. Mean seasonal encounter rates (\pm standard sample deviation) by season from Summer 2011 to Autumn 2015 for Northern Riffleshell males (dashed green line) and females (solid orange line) with standard deviation bars.

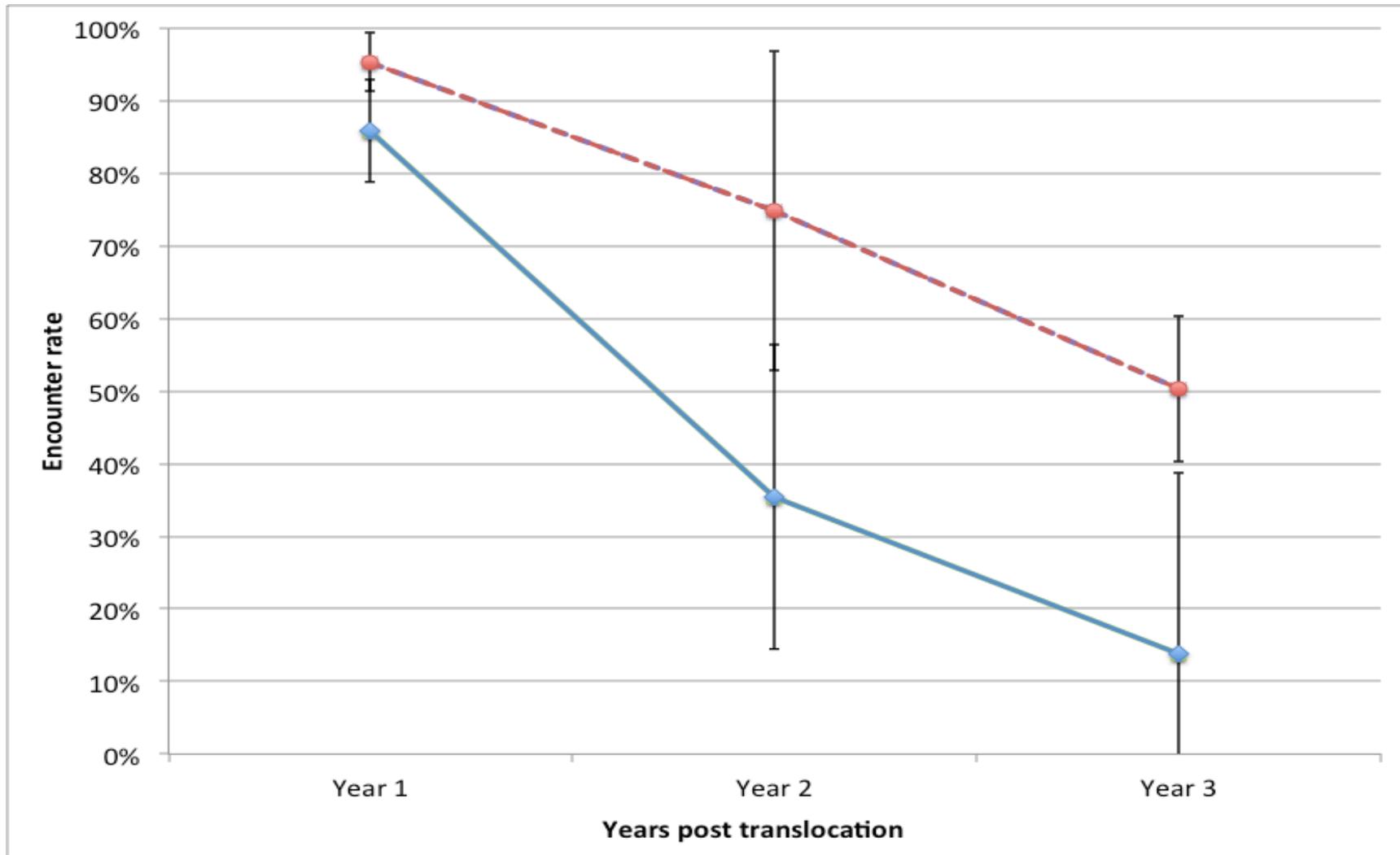


Figure 4. Mean annual encounter rates (\pm standard sample deviation) by year post translocation for Northern Riffleshell (solid blue line) and Clubshell (dashed red line) with standard deviation bars.



Figure 6. Location of where a Clubshell (PIT tag number 3DD.003B9C523F) was released in 2012 (top bullet) and where it was detected in November 2015 (lower bullet). This individual was found alive in Summer 2015 in the location where it was originally placed, and although detected in November 2015, the individual was buried in the substrate and was not found recovered.